Curriculum Developments in German Speaking Countries

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1. Introduction

Up to 1970 for the most part only combinatorics was covered by the curricula for secondary level schools in Austria, after which probability was included, drawing heavily on combinatorics and the Laplace probability concept. Matters changed in 1980 when the last two years before the final examinations (Matura) got a full curriculum in probability and statistical inference with a small component of descriptive statistics. Curricula were revised again in 1989. Now descriptive statistics is covered in grades 1-4 (ages 10-14) and more deeply in grade 5 (age 15), including exploratory data analysis. Probability is tightened, conditional probability reduced to a minimum level, and stochastics is completed in grade 7 to ensure that time constraints in the final year do not prevent teachers from covering it in class. The final year offers an optional opportunity to deepen understanding of previous material.

The development in Western Germany was roughly the same, but started about 10 years earlier and differed a little among the several federal states which preserve some sort of autonomy in this respect. There is more analysis of simple games and elementary probability at ages 10-14 in Western Germany and a choice of different special subjects at age 17. Mathematics can be covered by basic or advanced courses and may be avoided in the year before the final examination (grade 12, age 18, comparable to the final year in Austria). Full advanced courses cover (intentionally) many topics of introductory statistics at university level.

2. Trends in teaching stochastics

In the 1970s, as part of the New Math wave, probability was seen as a good opportunity to apply set theory and logic; boolean algebra of sets of events was important then. Combinatorics was the main means of evaluating probability and many problems just dealt with enumeration of cases in a tricky combinatorial situation. Descriptive statistics played a minor role, if any. With the decline of the New Math movement the role of applications was reaffirmed, and both descriptive and inferential statistics increased in importance.

However, applications were not taught as pragmatic examples to show that mathematics helps to organise, nor were the skills involved in applying the procedures a focus of effort. There was a heavy accent on teaching something like model building. How to mathematise, generalise, specify, make special assumptions; how to reach a suitable model for the problem at the outset, and how to interpret the results of model calculations afterwards, were among the driving forces supporting the "applications wave" following New Math.

The technique of simulation was used in two ways, first to reduce complicated analysis of, say, probability games, and to get results, and secondly, to give a concrete meaning for inferential methods, shifting their interpretation heavily in the frequentist direction. Soon some proposals were put forward which combined a new style of work, namely projects, with statistics. Calculators were used to an ever increasing extent, which may lead now to a qualitative change in statistics education, with the stress shifting from mathematical relations and functions towards applications. However, this process is still ongoing and does not yet appear in curricula or in the broader framework of statistics teaching.

3. Organisation of schools

Several factors influence design of curricula in Austria which may differ from those affecting English speaking countries. Besides the general education Grammar schools there are technical and commercial schools (ages 15-19) whose final examination also permits entry to university. This has an impact on who attends the school. However, these vocational schools have no real counterpart in Western Germany. Curricula are usually not very detailed, though things are changing now. They provide some sort of a framework, compulsory but not taken literally.

There is a project group of researchers and school administrators that takes some initiative in revision of curricula. This group discusses drafts of new curricula which are then opened to public comment. Finally, a commission in the Ministry of Education might complete new curricula. The project group also publishes booklets with more detailed explanations to the curriculum, especially for new topics.

Final examinations are not organised at a nationwide level but individually at schools where each of the teachers delivers three proposals for a final examination to the school authority; one of these proposals is selected for the examination. There are some guidelines as to which subjects are to be covered by this examination, but no more. Thus, individual teaching is allowed a bit more freedom, although textbooks serve as some smoothing medium. These textbooks have to pass a commission installed by the Ministry of Education which checks if they are compatible with the curriculum and if they cover it.

Teachers have the rank of full graduates who have to study two different subjects (say mathematics and geography) for 4-5 years, graduating as Magister which is comparable to MA or MSc. Passing the final examination (Matura) allows students entrance to all universities. A large percentage go on to study; however, from vocational schools, many leave directly for a job.

4. Cultural traditions

There is a distinctly different approach towards philosophy in the German tradition than say in the British one. The preference for highly structured theoretical concepts might have one root in the more complex German language. Applications are esteemed less highly than theory. The pragmatic view of applications is rarely appreciated. In this tradition, and in the light of the controversial discussions of the late 1960s, a new idea was born - the so-called Bildungswissenschaften and the Didaktik. Both concepts have no English counterpart; even a direct translation is missing. Pedagogical sciences and didactics both completely miss the intended connotation of the German names.

Bildungswissenschaften has something to do with organising different scientific approaches to investigating education from any perspective possible - which type of education, for what reason, at which age, in which sequence, and so forth. Didaktik is the melding of a discipline like mathematics with any science that could be a promising source for illuminating this subject from a teaching perspective: (cognitive) psychology, sociology, philosophy of science, and so forth, all with the aim of getting theoretical insight into teaching or learning processes and to improve actual instruction. There was a big drive for this new science to become professional; thus jargon, theoretical concepts, hard methods of neighbouring disciplines were rapidly incorporated. To give only two examples, methods of argument from analytical philosophy, and statistical methods, were used to clarify the database of information on problems, and to decide between more and less promising research issues.

5. Specifics

Turning now to the teaching of probability and statistics, differences from cultural traditions appear from the very beginning, even the labelling is different. The word "stochastics" is used to cover probability and statistics and even descriptive statistics. The accent in the past 20 years has been on probability, though things are changing now. At first there was even a strong reluctance towards including probability and it was taught only in tight connection to combinatorics. Then the link to the axiomatic approach and logic developed. A characteristic endeavour of this period was to structure and organise previous chaos by steps of "mathematising", ending up with a set of precisely stated axioms, even if only a reduced set of Kolmogorov axioms. Within this topic of mathematising, the relation between the final mathematical structure and the various interpretations of the concepts used was supposed to play a prominant role.

A more or less final step within this effort is the derivation of theorems on the basis of axioms. Chebyshev's inequality and Bernoulli's law of large numbers are covered to serve as a justification of the frequentist interpretation and to clarify the complex connections between probability and relative frequencies. This is also thought to be the base of inferential statistics. Within this context of mathematising chaos, the key role of independence should be brought out into the open.

The foregoing might be summed up as an accent on development within probability theory, on concepts, and on their relation to reality; a stress on precise language, to which skills in simple calculations of probability might sometimes have been sacrificed. "Stochastic thinking" is a motto which is embedded in this line of approach, and it is far more popular in the Germanic countries than in Britain or the US. Stochastic thinking is a peculiar form, different from usual thinking, and improved by developing parts of mathematical processes of probability to classify the material. Interestingly enough, stochastic thinking has been reduced to somewhat theoretical concepts, which should penetrate it, and to the frequentist interpretation. Subjectivist views, which might be improved by adequate teaching of Bayes' formula, have never been considered.

The motto "statistical literacy (numeracy) for all" has had impact only recently on our discussions. Now, descriptive and exploratory techniques are introduced at lower secondary school level as their mathematical requirements seem to fit there. When descriptive statistics was used at upper secondary level, it was tightly linked to the idea of mathematisation. To mathematise a real problem, generalise it, make assumptions, end up with a model result and interpret that carefully; these were the aims. Applications were made exemplary, but what counted most was not to solve the single problem, but to learn the general process of mathematising.